United States Patent [19]

Enger

[11] **4,011,861**

[45] **Mar. 15, 1977**

[54] **IMPLANTABLE ELECTRIC TERMINAL FOR ORGANIC TISSUE**

[75] Inventor: **Carl C. Enger,** Lakewood, Ohio

[73] Assignee: **Case Western Reserve University,** Cleveland, Ohio

[22] Filed: **Oct. 28, 1975**

[21] Appl. No.: **626,191**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 457,467, April 3, 1974, abandoned.

[52] **U.S. Cl.** ..... **128/2.06 E;** 128/2.1 E; 128/DIG. 4; 128/418; 128/419 P; 128/419 C; 128/419 E; 128/419 F

[51] **Int. Cl.**[2] **A61B 5/04;** A61N 1/04

[58] **Field of Search** ..... 128/418, 419 P, 419 B, 128/419 C, 419 D, 419 E, 419 F, 404, 2.06 E, 2.1 E, DIG. 4; 3/1

[56] **References Cited**

UNITED STATES PATENTS

3,314,420	4/1967	Smith et al.	128/92 R
3,345,989	10/1967	Reynolds	128/419 P
3,596,662	8/1971	Bolduc	128/418
3,663,965	5/1972	Lee et al.	3/1
3,737,579	6/1973	Bolduc	128/418
3,752,162	8/1973	Newash	128/419 P

OTHER PUBLICATIONS

B535,466, Jan. 1976, Cannon, 128/419 P.

Guyton et al., "Capacitor Electrode . . . Reactions," Science, vol. 181, pp. 74–76, July, 1973.

Trimble, "Clinical Engineering," Medical Instrumentation, vol. 8, No. 2, Mar.–Apr., 1974.

Gertler, "Interface for Passing Lead Wires . . . Animals," IEEE Trans. on Bio–Med. Eng'g, vol. 18, No. 1, Jan. 1971.

Cassel et al., "Implanted Ag–AgCl Mag. Power Sources," Med. Inst., vol. 7, No. 3, May–Aug., 1973, pp. 176–179.

Becker et al., "Electrical Stimulation of Hard Tissue Growth . . . Devices," Oct. 30, 1973.

Primary Examiner—Robert W. Michell

Assistant Examiner—Lee S. Cohen

[57] **ABSTRACT**

A non-reacting implantable electric terminal for organic tissue, which is porous and intermeshes with the tissue including blood capillaries without the formation of a fibrous tissue encapsulation that reduces the sensitivity of tissue to electricity. This electric terminal is composed of tissue-compatible implantable material or materials at least one of which is electrically conductive, such as platinum, or an alloy, and which has on at least one surface thereof a porous material or layer having pores that are interconnected and continuous so that body electrolytes and/or tissue containing blood capillaries can contact the electrically conductive material through said porous material or layer. The pores of this material or layer also must have an average diameter sufficient to permit blood vessels to form in them, i.e. a diameter preferably between about 10 and 500 microns. This porous material may be either electrically conductive or electrically non-conductive, and may comprise a porous metal, carbon, ceramic, such as one containing aluminum oxide, and/or a synthetic polymer, or elastomer, such as one containing a silicone, a fluorocarbon, or an epoxy resin. The shape of the electric terminal may vary as desired, and the more interconnected pores it contains the better. This electric terminal may either be placed on the surface of the tissue like a plate or disk, or be inserted into the tissue.

26 Claims, 7 Drawing Figures